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(71) Applicant
Diesel Kiki Co Ltd (Japan),
6–7 Shibuya 3-chome, Shibuya-ku, Tokyo, Japan

(72) Inventors
Teruo Hirano
Yuji Sato

(74) Agent and/or Address for Service
Marks & Clerk,
57–60 Lincoln's Inn Fields, London WC2A 3LS

(54) Shift lever unit for motor vehicle transmission

(57) The unit comprises a plurality of juxtaposed differential shift cylinders 1 a-d, each having a pair of openings 2a,2b for the passage of hydraulic fluid, and a piston rod 3a-d. A connecting lever 4a-d is disposed on the piston rod 3a-d of each shift cylinder 1a-d and coupled with the transmission to effect a distinct speed shift. A hydraulic fluid source 10 is connected with one opening 2a of each shift cylinder. A tank 14 is connected with the other opening 26 of each shift cylinder. A first directional control valve 15a-d, with two ports and two positions, is disposed between the openings 2a,2b of each cylinder 1a-d to selectively communicate the openings. A second directional control valve 17a-d, with two ports and two positions, is disposed between the said other opening 2b of each shift cylinder 1a-d and the tank 14. Positions sensor 6a-d detect the shift positions and send signals to a computer which controls the valves.

FIG. 2

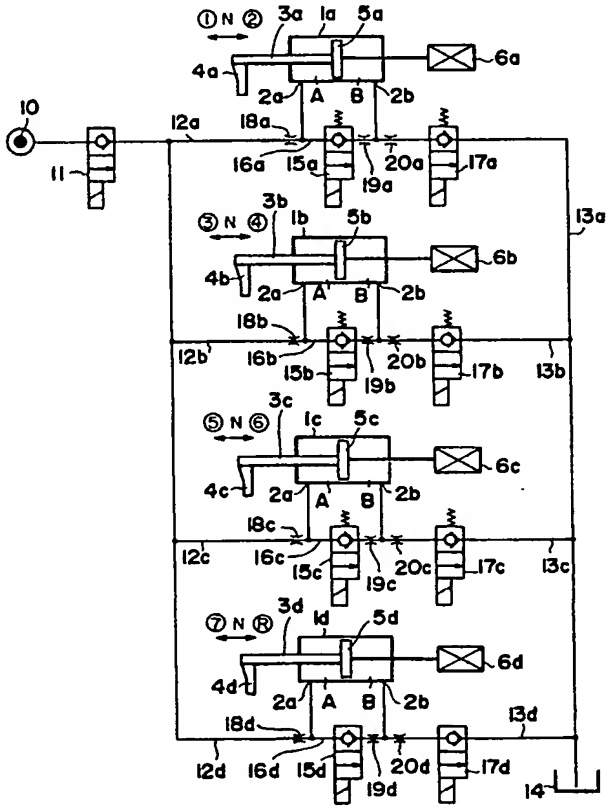

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FIG. 1

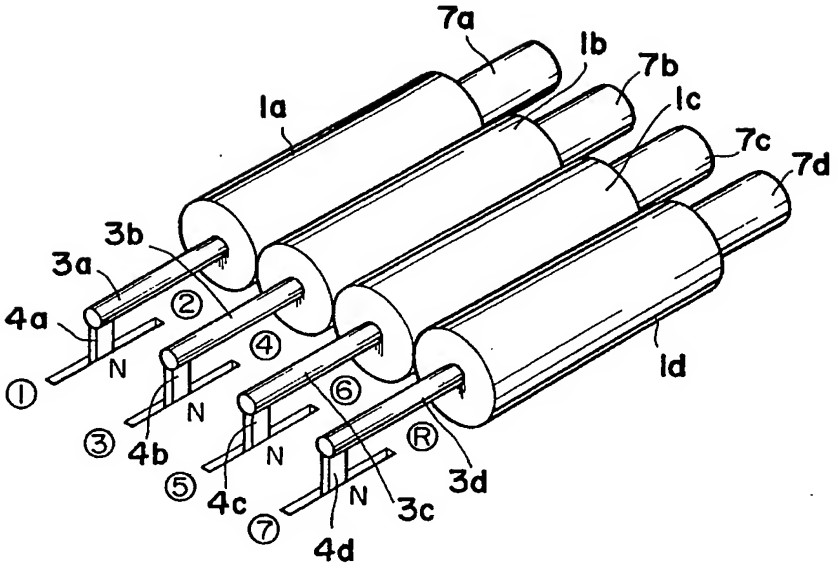

FIG. 3

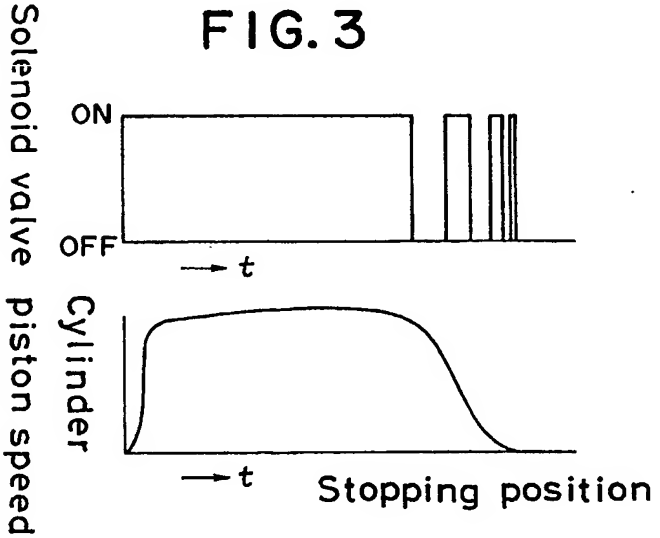

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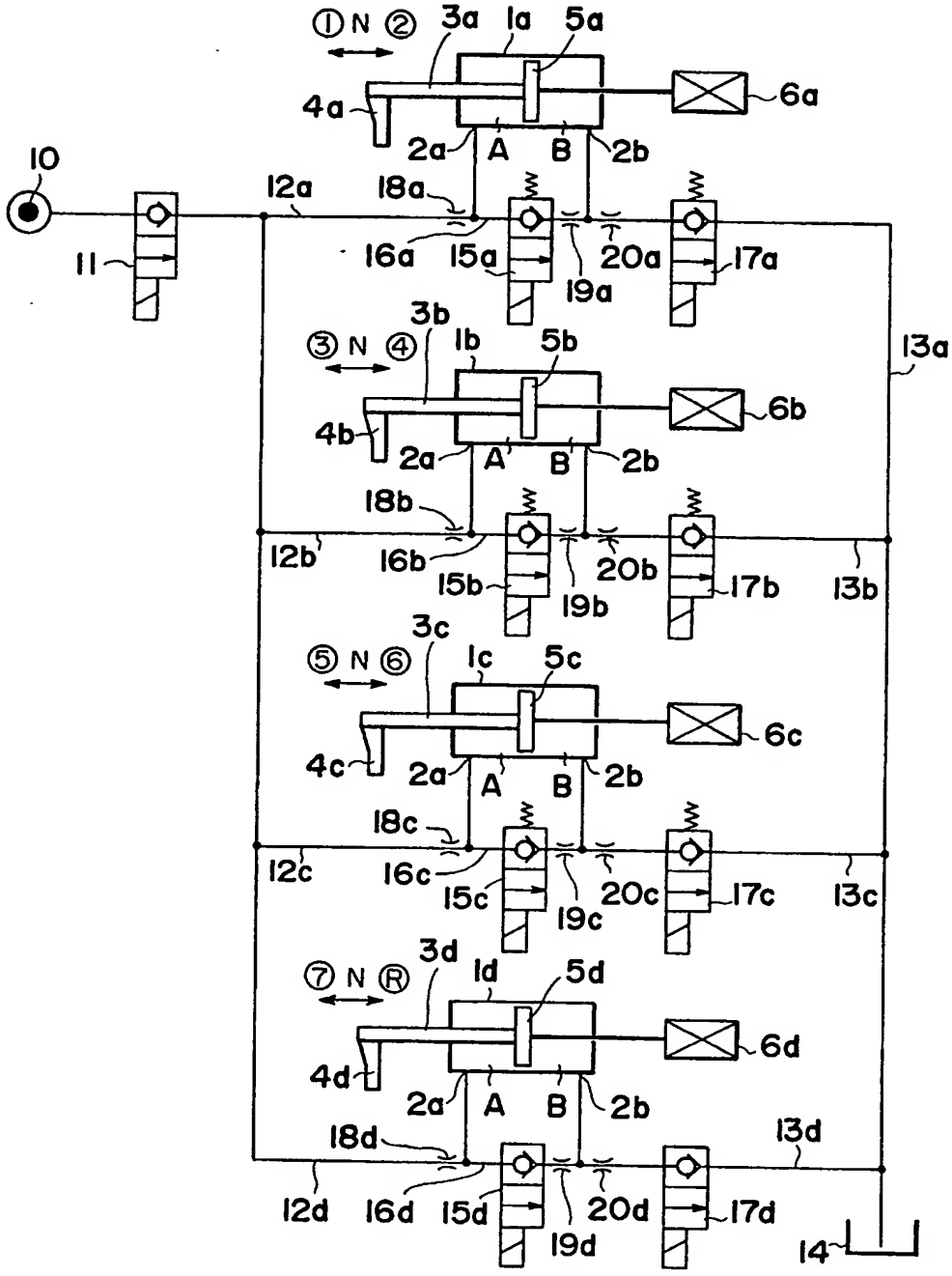
FIG. 2



SPECIFICATION

Shift lever unit for motor vehicle transmission

The present invention relates to a shift lever actuator unit for changing gear wheels in a motor vehicle transmission.

Automatic actuator for motor vehicle transmissions are known, which comprise two hydraulic cylinders for displacing an internal lever, respectively, in two directions normal to one another, namely in a "shift" direction and a "select" direction, solenoid operated directional control valves for selecting the direction of movement of pistons in the respective cylinders, and a control circuit for controlling the valves to automatically control the operation of the actuator.

One such known automatic actuator is disclosed in Japanese Patent Application No. 57-59078 assigned to the present applicant. The disclosed actuator comprises a select actuator or cylinder whose piston rod is secured to an internal lever for displacing the latter in a select direction, and a shift actuator or cylinder having a piston rod engageable with an upper end of the internal lever to pivot the internal lever about the piston rod of the select cylinder in a shift direction.

The disclosed system thus constructed is disadvantageous in that, since each shift position is determined by an end face of the piston rod of the select cylinder, an unpleasant shock noise is produced when the piston rod is stopped. The shock noise would result in a substantial reduction in durability of the actuator.

It is an object of the present invention to provide a shift lever unit for a motor vehicle transmission, which can overcome or substantially eliminate the foregoing difficulties of the prior apparatus.

Another object of the present invention is to provide a shift lever unit for a motor vehicle, which is simple and durable in construction, which can operate without producing unpleasant shock noise, and which is easy to control.

According to the present invention, there is provided a shift lever unit for a motor vehicle transmission, comprising: a plurality of juxtaposed differential shift cylinders each having a pair of openings for the passage of hydraulic fluid, and a piston rod; a connecting lever disposed on said piston rod of each shift cylinder and coupled with the transmission to effect a distinct speed shift; a hydraulic fluid source connected with one of said openings of each shift cylinder; a tank connected with the other opening of each shift cylinder; a first directional control valve with two ports and two positions, disposed between said one and other openings of each cylinder to selectively communicate said one and other openings; and a second directional control valve with two ports and two positions, disposed between said other opening of each shift cylinder and said tank.

These and other objects, advantages and features of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which a preferred embodiment incorporating the principles of the present invention is shown by way of illustrative example.

In the accompanying drawings:

FIG. 1 is a schematic perspective view of a shift lever unit;

FIG. 2 is a schematic hydraulic circuit diagram of the shift lever unit shown in FIG. 1; and

FIG. 3 is a graph illustrating the operation of a solenoid controlled directional control valve with respect to the piston speed of a cylinder.

As shown in FIG. 1, a shift lever unit embodying the present invention comprises a plurality of shift cylinders (four in the illustrated embodiment) 1a—1d disposed in close juxtaposition. The shift cylinders 1a—1d are of the differential type which utilizes the difference in effective area on opposite sides of a piston 5a—5d (FIG. 2) of each cylinder. Each of the differential shift cylinders 1a—1d has at opposite ends thereof a pair of openings 2a, 2b through which hydraulic fluid flows into and out of the cylinder. In the illustrated embodiment, the shift lever unit is incorporated in a motor vehicle transmission (not shown) having seven forward speed ranges and the reverse. To this end, the first shift cylinder la is utilized for the first and second speeds, the second shift cylinder 1b for the third and fourth speeds, the third shift cylinder 1c for the fifth and sixth speeds, and the fourth shift cylinder 1d for the seventh speed and the reverse.

Each of the shift cylinders 1a—1d includes a single output rod or piston rod 3a—3d connected to a corresponding connecting lever 4a—4d which coupled with the transmission for transmitting thereto the amount of displacement of the piston rod 3a—3d. This displacement is detected by a position sensor 6a—6d connected with each piston 5a—5d remote from the piston rod 3a—3d. The position sensors 6a—6d comprise potentiometers known per se which are mounted on the respective cylinders 1a -1d remote from the piston rods 3a—3d and which are housed in cylindrical covers 7a—7d, respectively.

A hydraulic control circuit for driving the differential shift cylinders 1a—1d is shown in FIG. 2 and comprises a hydraulic fluid source 10 for supplying hydraulic fluid to the shift cylinders 1a—1d via a main diectional control valve 11 with two ports and two positions. Stated more specifically, the openings 2a of

the shift cylinders 1a—1d are held in fluid communication with the source 10 via the valve 11, respectively through lines 12a—12d, whereas the openings 2b of the shift cylinders 1a—1d communicate with a tank 14, respectively, through lines 13a—13d.

The pair of openings 2a, 2b of each shift cylinder 1a - 1d is connected by a line 16a—16d in which is disposed a first directional control valve 15a—15d with two ports and two positions. Second directional control valves 17a 17d with two ports and two positions are disposed respectively in lines 13a—13d. The main, first and second directional control valves 11, 15a—15d and 17a - 17d are solenoid controlled and have one valve position constituting a check valve to block fluid communication therethrough, and the other valve position to open the ports thereof for allowing hydraulic fluid to pass therethrough. The valves 11, 15a—15d, 17a—17d may be replaced by directional control valves with two ports and two positions, which open the ports at one valve position and closes the ports at the other valve position.

The first and second directional control valves 15a -15d, 17a—17d are subjected to a duty factor control as shown in FIG. 3. The exciting current applied to solenoid of each valve 15a—15d, 17a -17d are controlled when the piston rod 3a—3d of the corresponding shift cylinders Ia - Id approach its opposite end positions or stop positions so as to gradually decelerate the speed of the piston rod 3a—3d.

A first flow metering valve 18a—18d is disposed in each respective line 12a—12d upsteam of the opening 2a of the shift cylinder 1a—1d. Likewise, a second flow metering valve 19a—19d is disposed in each respective line 12a—12d upstream of the opening 2b of the shift cylinder 1a—1d, the valve 19a—19d being disposed between the first directional control valve 15a—15d and the opening 2b. A third flow metering valve 20a—20d is disposed in each respective line 13a—13d between the opening 2b and the second directional control valve 17a -17d. The first to third flow metering valves 18a—18d, 19a—19d, 20a—20d restrict the rate of flow of hydraulic fluid passing therethrough, however, they may be omitted where the line diameter is below a predetermined valve.

The shift speed of the shift lever unit is controlled jointly by the flow metering valves 18a—18d, 19a—19d, 20a—20d and exciting pulses applied to the solenoids of the first and second directional control valves 15a—15d, 17a—17d.

Operation of the shift lever unit thus constructed is described first with respect to the shift cylinder 1a. When the piston rod 3a and hence the connecting lever 4a is to be moved from the neutral position N of FIG. 1 forwardly to a position indicated by the numeral 1, the main directional control valve 11 is actuated to change its valve position for opening the ports thereof, and the first directional control valve 15a is actuated to open its ports, thereby allowing hydraulic fluid to flow through the openings 2a, 2b, respectively, into opposite chambers A, B, in the shift cylinder 1a. Since the effective area of the piston 5a is larger at the chamber B than at the chamber A, the piston 5a is displaced leftward (FIG. 2) to extend the piston rod 3a, thereby moving the connecting lever 4a toward the position 1. The arrival of the connecting lever 4a at the position 1 is detected by the position sensor 6a which in turn sends a detection signal to a control circuit (not shown) to cut off the exciting current to the solenoid of the first directional control valve 15a. The valve 15a is returned by a spring to the normal closed valve position.

When the piston rod 3a and hence the connecting lever 4a is to be moved rearwardly from the neutral position N to a position indicated by the numeral 2, the main directional control valve 11 and the second directional control valve 17a are actuated to open their ports. This valve actuation causes hydraulic fluid to flow from the source 10 through the opening 2a into the chamber A and, at the same time, to flow out from the chamber B through the opening 2b. As a result, the piston 5a is displaced rightward (FIG. 2) to retract the piston rod 3a, thereby moving the connecting lever 4a from the neutral position N toward the position 2. Upon arrival of the connecting lever 4a at the position 2, the exciting current to the solenoid of the second directional control valve 17a is cut off so that the valve 17a is automatically returned to the normal closed position under the force of the spring. The shift cylinder 1a is controlled in the manner as described above.

The shift cylinders 1a—1d are controlled by control signals generated from a microcomputer (not shown). The microcomputer computes optimum shift positions for the respective speeds in dependence of the vehicle accelerator pedal position or the engine r.p.m., and outputs control signals representing such optimum shift positions, to the main directional control valve 11, and the first and second directional control valves 15a—15d, 17a—17d.

For instance, when the motor vehicle is to be started, the main directional control valve 11 and the first directional control valve 15a are actuated to open their ports for displacing the position 5a and hence the piston rod 3a forwardly to bring the connecting lever 4a into the position 1. Now, the gear wheels in the transmission is changed in the first speed position. This condition continues until when

the vehicle speed reaches to several km/h whereupon the first directional control valve 15a is closed and, at the same time, the second directional control valve 17a is opened. These valve positions cause the piston 5a and hence the piston rod 3a to be retracted until the connecting lever 4a reaches the position 2, thereby shifting the transmission to the second speed. Upon arrival of the connecting lever 4a at the position 2, the second directional control valve 17a is closed.

A further increase in vehicle speed causes the first directional control valve 15a to be opened to return the piston rod 3a and hence the connecting lever 4a to the neutral position N. Then, the first directional control valve 15a is closed and the first directional control valve 15b for the shift cylinder 1b is opened to displace the piston rod 3b forwardly until the connecting lever 4b arrives at a position indicated by the numeral 3. Thus, the transmission is shifted from the second speed to the third speed, whereupon the first direction control valve 15b is closed. As understood from the foregoing description, the transmission is shifted successively from the first speed to the seventh speed. The speed change is achieved at optimum shift positions depending upon demand signals from the microcomputer.

The shift lever unit thus constructed has various advantages: With a plurality of juxtaposed shift cylinders selectively operated to effect speed change, it is unnecessary to provide a select cylinder for displacing the connector lever in a select direction normal to the direction of movement of the respective piston rods of the shift cylinders. As a result that the shift lever unit is simple in construction as a whole, and is free from unpleasant shock noise which would otherwise be produced by the select cylinder. The piston rod of each shift cylinder makes a linear reciprocating motion to provide improved strength and durability. The shift cylinders having such piston rods are easy to control.

Obviously, many modifications and variation of the present invention are possible in the light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practised otherwise than as specifically described.

CLAIMS

1. A shift lever unit for a motor vehicle transmission, comprising:

(a) a plurality of juxtaposed differential shift cylinders each having a pair of openings for the passage of hydraulic fluid, and a piston rod;

(b) a connecting lever disposed on the piston rod of each shift cylinder and coupled with the transmission to effect a distinct speed shift;

(c) a hydraulic fluid source connected with one of the openings of each shift cylinder;

(d) a tank connected with the other opening of each shift cylinder;

(e) a first directional control valve with two ports and two positions, disposed between the said openings of each cylinder to selectively communicate the said openings; and

(f) a second directional control valve with two ports and two positions, disposed between said other opening of each shift cylinder and the tank.

2. A shift lever unit according to claim 1, wherein each of the first and second directional control valves opens its ports at one valve position and closes its port at the other valve position.

3. A shift lever unit according to claim 1, wherein each of the first and second directional control valves opens its ports at one valve position and constitutes a check valve at the other valve position.

4. A shift lever unit according to any of claims 1 to 3, including means for decelerating the speed of movement of the piston rod as the connecting lever approaches a predetermined shift presition.

5. A shift lever unit according to claim 4, the decelerating means comprising a pair of flow metering valves disposed, respectively, upstream of the pair of openings of each shift cylinder, and a further flow metering valve disposed between said other opening and the second directional control valve.

6. A shift lever unit according to claim 4, each of the first and second directional control valves comprising a solenoid controlled valve, the decelerating means comprising a solenoid of each said directional control valve.

7. A shift lever unit according to any of claims 1 to 6, including a main direction control valve with two ports and two positions disposed between the hydraulic fluid source and said one opening of each shift cylinder for selectively communicating them together.

8. A shift lever unit substantially as described with reference to, snd as shown in, the accompanying drawings.

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